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Introduction to Chassis Dynamics

Model: All

Production: All

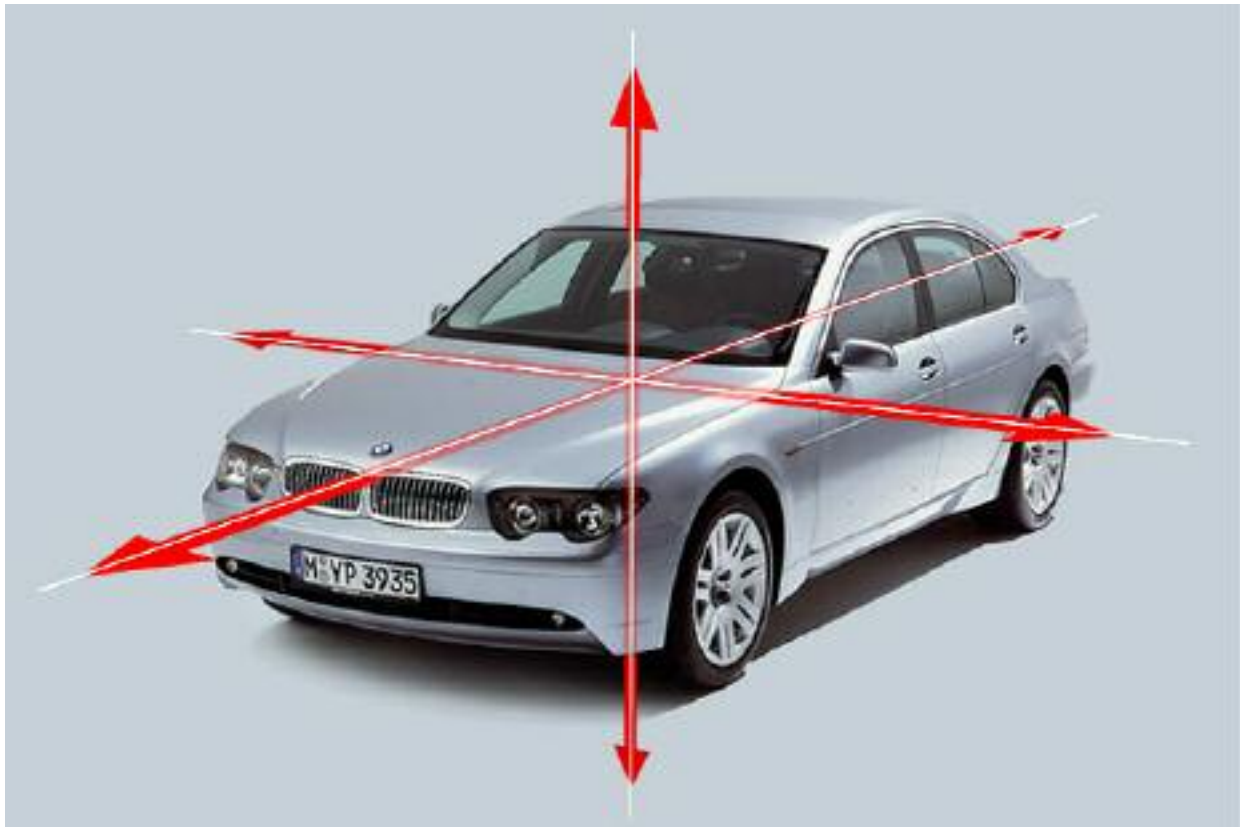
OBJECTIVES

After completion of this module you will be able to:

- Understand Chassis Dynamic Principles in BMW Vehicles
- Understand Chassis Related Technology

Introduction to Chassis Dynamics

One of the trademark characteristics of a BMW is its ability to handle like a sports car and still provide a pleasing driver experience. To keep ahead of the competition, BMW has continually raised the bar from a performance standpoint. BMW engines are usually "Best in Class" in the premium segment. However, to remain a leader it is not only the engine which must outperform the rest of the pack. The chassis must allow for optimal comfort and safety as well as superior handling and braking.



This training module will help the technician understand the basics of vehicle dynamics. Terminology, as it applies to BMW chassis systems, will also be explained in this section. A thorough understanding of current chassis technology is needed to diagnose and perform service procedures of these vehicles.

The information learned in this training module will provide fundamental knowledge needed to understand such systems as Dynamic Stability Control, Active Steering and Active Roll Stabilization.

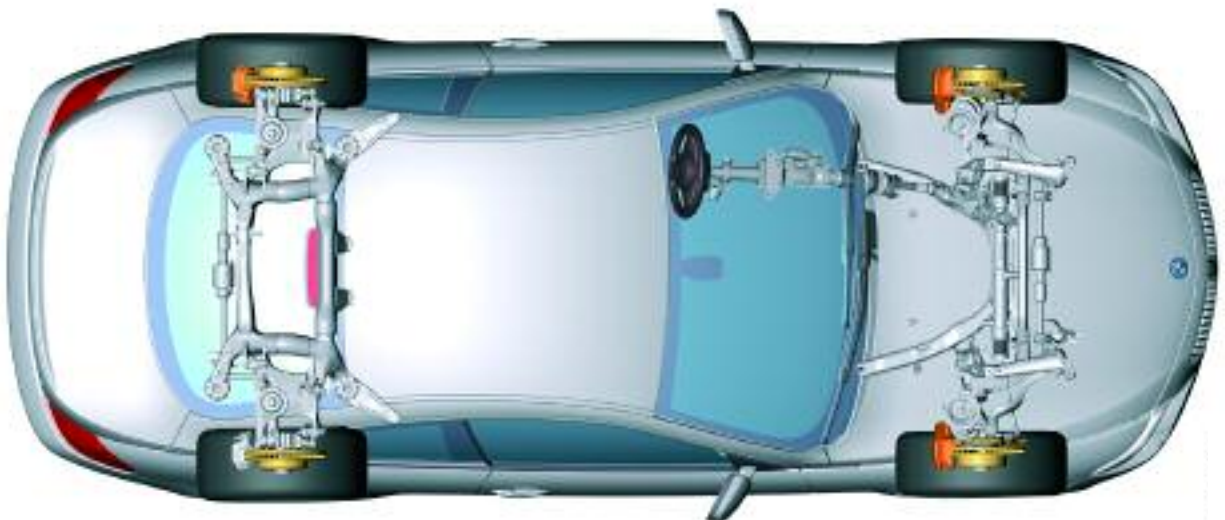
Vehicle Dynamics

A vehicle's cornering performance is also referred to as its self-steering properties. This handling performance is considerably influenced by the changing ratio of lateral force to wheel load on the front and rear axles. Lateral force increases as centrifugal force increases.

BMW vehicles are designed to have the best possible weight balance. A 50/50 weight ratio between the front and rear axles is always the intended design target.

The engineers at BMW always strive to achieve these goals during the design process. This effort can be seen by the use of lightweight components. New materials such as aluminum, magnesium and high-strength steel are used throughout various models. Even new materials, such as plastic, have been incorporated into the body.

For example, the E60 takes advantage of the lightweight front end technology (GRAV). On all modern BMW vehicles, the vehicle battery is installed in the rear of the vehicle for better weight balance.



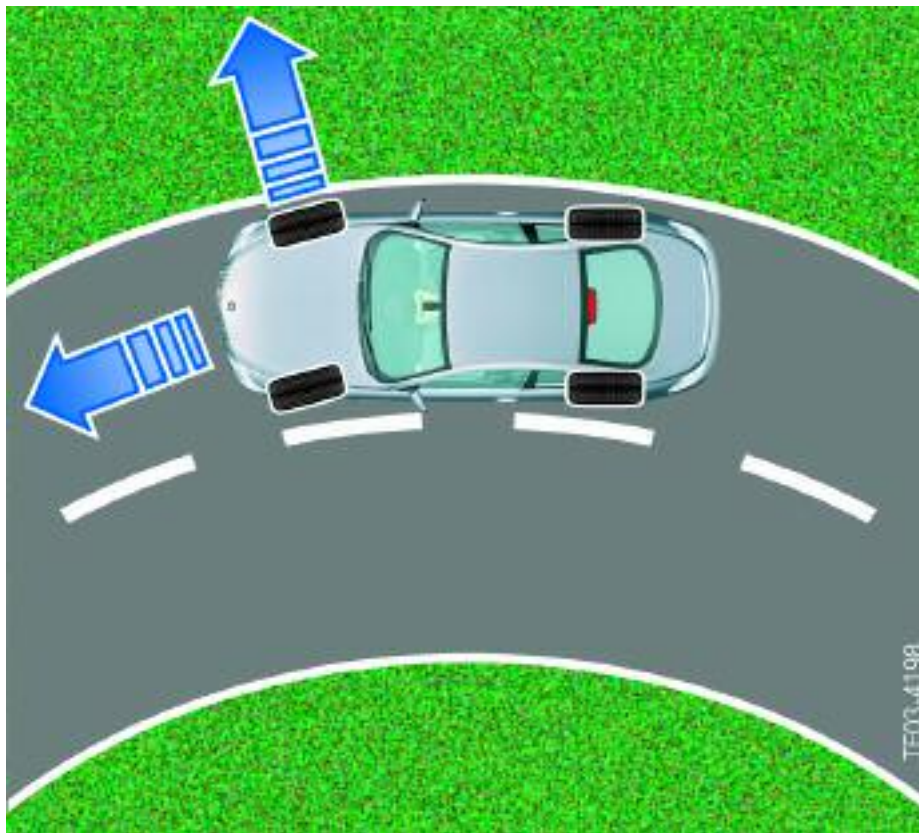
Neutral Steer

The slip angles arising as a result of lateral force are the same on the front and rear axles. Neutral cornering facilitates the best use of lateral forces and thereby the highest limit cornering speeds. However, it also reduces the subjective feel for vehicle stability. In addition the breakaway cannot be calculated as it can occur via both the front and rear axles.

Understeer

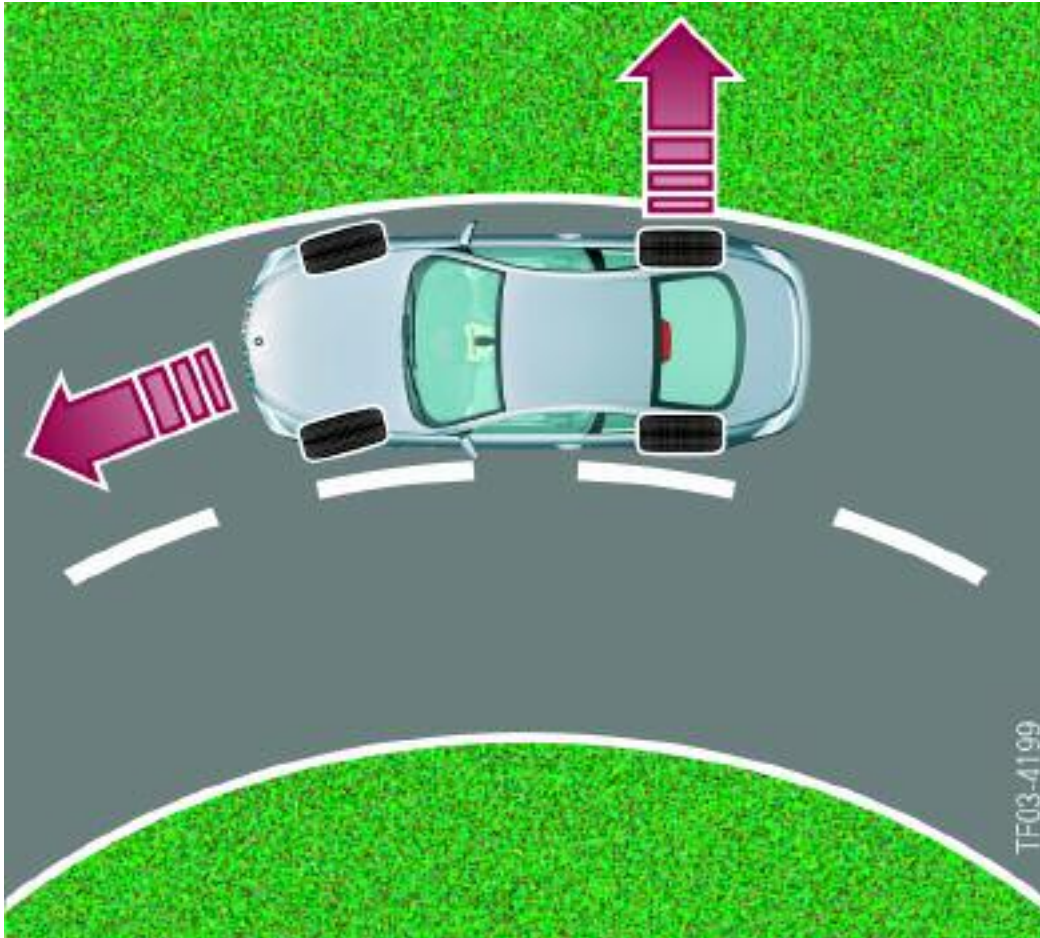
The ratio of lateral force to wheel load is greater on the front axle than on the rear. The vehicle follows a larger cornering radius than that corresponding to the steering angle. It also slides to the outside of the turn via the front axle. When designing the chassis, this behavior is often the preferred option, because when the vehicle breaks away it can be returned to a straightline course which it is possible to calculate. Take, for example, a vehicle which begins to break away via the front axle while being driven to the limits; if the steering angle is then reduced, the vehicle will recover to assume a straightline course.

BMW chassis are designed so that they have slight understeer characteristics.



Oversteer

The ratio of lateral force to wheel load is greater on the rear axle than on the front. The vehicle follows a smaller radius than that corresponding to the steering angle. The vehicle slides to the outside of the turn via the rear axle.

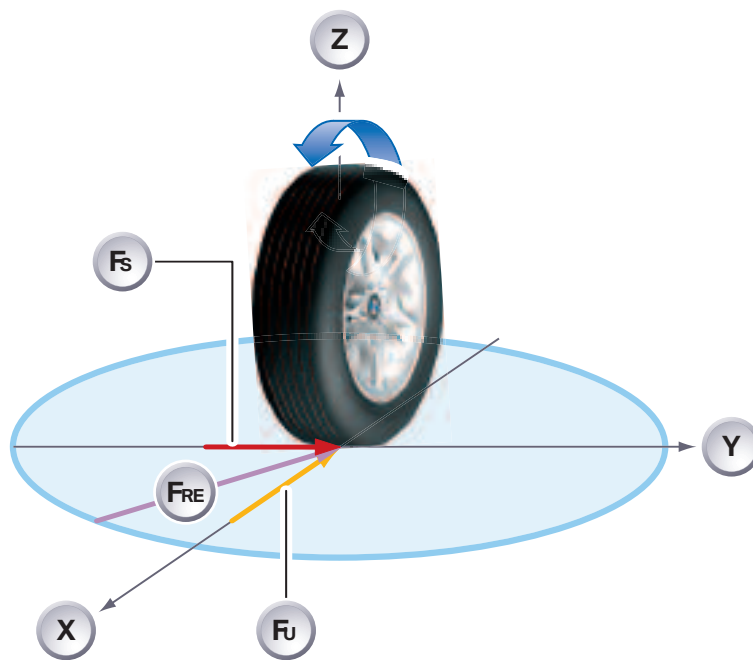


Chassis Forces

The chassis connects the vehicle with the road. Both force and drive torque are transferred to the road via the chassis. The chassis also has to absorb all cornering forces when the vehicle is cornering.

The chassis is therefore exposed to a huge number of forces and moments all of which act in different ways. It is essential that all these forces and moments can be transmitted in an optimum way via the tire contact areas.

As vehicles get more powerful and demands for ride comfort and driving safety rise, so the demands placed on the modern chassis increase considerably too.



Index	Explanation	Index	Explanation
Fv	Wheel contact force	Fre	Resulting force
Fu	Driving force	K	Maximum force
Fs	Cornering force	X,Y,Z	Coordinate axes

Kinematics

From a physics point of view, kinematics are the laws which give rise to sequences of movements.

Where chassis engineering is concerned, kinematics is the sequence of movements at the wheels and wheel-guiding components. Kinematics therefore have a direct effect on the position of the wheel for the respective load conditions.

Longitudinal Forces

Longitudinal forces act on the vehicle through the vehicle centerline. These forces are created by acceleration and braking. Also, any up or downhill movement will influence the longitudinal forces acting on the vehicle.



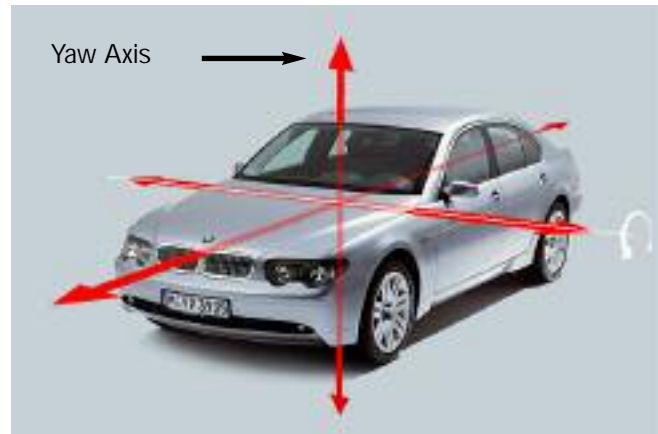
Lateral Forces

Lateral forces are also known as “transverse” forces. These forces are most prevalent during turns. Crosswinds also contribute to lateral force.



Rotational Forces

Rotational forces are more commonly known as “yaw”. Yaw motion is the vehicle rotation around a vertical axis. These forces are also experienced during turns. The speed of this force indicates the degree of turning force.



Tire contact area

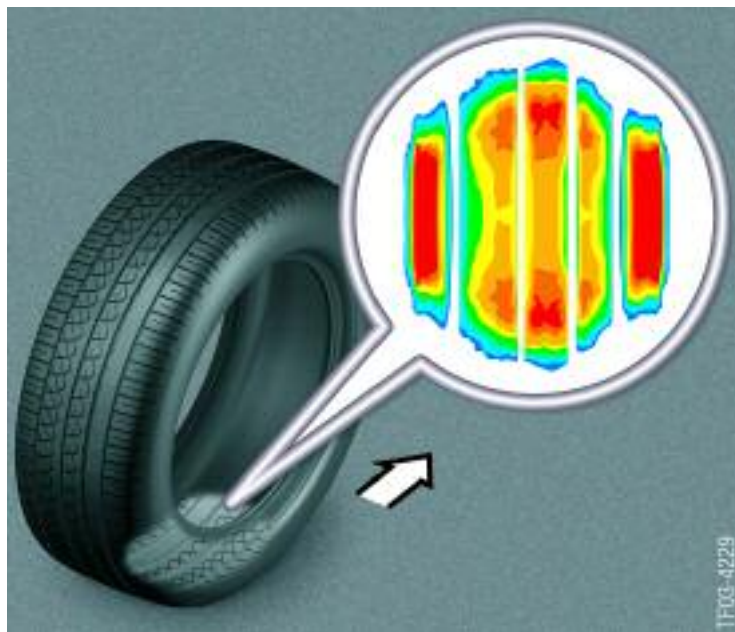
The tire contact area is the area which is covered by the wheel standing on the road.



Tire contact patch

The tire contact patch is the effective contact area of a tire in operation. It is therefore the tire contact area which is deformed by interfering forces (lateral forces, braking and acceleration forces) and by road surface quality.

The tire contact patch therefore describes the area of road which is touched by the tire when the vehicle is in operation.



BMW suspension systems are designed to allow for the optimum contact patch when the vehicle is in operation. For example, the "double-pivot" suspension is designed to keep the outside front tire as close to a zero camber angle on turns.